

What is claimed is

1           1. An imaging device that outputs brightness information  
2   according to an amount of incident light, comprising:

3           an imaging unit that includes a plurality of unit cells  
4   arranged one dimensionally or two-dimensionally, each unit  
5   cell including a photoelectric conversion part that generates  
6   a first output voltage in a reset state and a second output  
7   voltage according to an amount of incident light, and each  
8   unit cell generating a reset voltage that corresponds to the  
9   first output voltage and a read voltage that corresponds to  
10   the second output voltage; and

11          an output unit operable to output, in relation to each  
12   unit cell, brightness information indicating a difference  
13   between the reset voltage and the read voltage when the read  
14   voltage is in a predetermined range, and brightness  
15   information indicating high brightness when the read voltage  
16   is not in the predetermined range.

1           2. The imaging device of Claim 1,

2   wherein the output unit includes:

3           a first output line that is connected to the imaging  
4   unit and receives the reset voltage and the read voltage output  
5   from each unit cell;

6           a second output line that is connected to a circuit of

7 a subsequent stage and outputs brightness information to the  
8 circuit of the subsequent stage;

9 a clamp capacitance that is connected in series between  
10 the first output line and the second output line; and

11 a bypass transistor that is connected in parallel with  
12 the clamp capacitance, and brings the first output line and  
13 the second output line out of conduction not to bypass the  
14 clamp capacitance in a first case where a voltage applied  
15 between terminals of the clamp capacitance is in the  
16 predetermined range, and brings the first output line and  
17 the second output line into conduction to bypass the clamp  
18 capacitance in a second case where the voltage applied between  
19 the terminals is not in the predetermined range.

1 3. The imaging device of Claim 2,

2 wherein the first case is where an electric potential  
3 of the first output line is higher than a barrier potential  
4 of the bypass transistor, and

5 the second case is where the electric potential of the  
6 first output line is equal to or smaller than the barrier  
7 potential of the bypass transistor.

1 4. The imaging device of Claim 3,

2 wherein the output unit further includes:

3 a sampling capacitance that is connected in series

4 between the second output line and a terminal for supplying  
5 a predetermined voltage;

6 a clamp transistor that is connected in series between  
7 the second output line and a terminal for supplying a reference  
8 voltage; and

9 a control unit operable to control a reset voltage to  
10 be output to the first output line in a state where the clamp  
11 transistor is ON and the second output line is set at the  
12 reference voltage, and then control a read voltage to be output  
13 to the first output line in a state where the clamp transistor  
14 is OFF, and

15 wherein when a reset voltage that is in the predetermined  
16 range is output to the first output line in a state where  
17 the clamp transistor is ON and the second output line is set  
18 at the reference voltage, an equivalent to a difference between  
19 the reference voltage and the reset voltage is held by the  
20 clamp capacitance, and then when a read voltage that is in  
21 the predetermined range is output to the first output line  
22 in a state where the clamp transistor is OFF, a voltage of  
23 the second output line changes from the reference voltage  
24 by an amount corresponding to the equivalent held by the clamp  
25 capacitance, so that brightness information indicating a  
26 difference between the reset voltage and the read voltage  
27 is output, and

28 when a read voltage that is not in the predetermined

29 range is output to the first output line in a state where  
30 the clamp transistor is OFF, the bypass transistor brings  
31 the first output line and the second output line into  
32 conduction to bypass the clamp capacitance and so the voltage  
33 of the second output line is replaced by the read voltage,  
34 so that brightness information indicating high brightness  
35 is output regardless of whether the reset voltage is in the  
36 predetermined range.

1        5. The imaging device of Claim 3,  
2        wherein the output unit further includes:  
3        a sampling capacitance that is connected in series  
4        between the second output line and a terminal for supplying  
5        a predetermined voltage;  
6        a clamp transistor that is connected in series between  
7        the second output line and a terminal for supplying a reference  
8        voltage; and  
9        a control unit operable to switch the clamp transistor  
10       ON in a state where a read voltage is output to the first  
11       output line, and then switch the clamp transistor OFF and  
12       controls a reset voltage to be output to the first output  
13       line, and  
14       wherein when the clamp transistor is switched ON in a  
15       state where a read voltage that is in the predetermined range  
16       is output to the first output line, an equivalent to a

17 difference between the reference voltage and the read voltage  
18 is held by the clamp capacitance, and then the clamp transistor  
19 is switched OFF and a reset voltage that is in the predetermined  
20 range is output to the first output line; and a voltage of  
21 the second output line changes from the reset voltage by an  
22 amount corresponding to the equivalent held by the clamp  
23 capacitance, so that brightness information indicating a  
24 difference between the reset voltage and the read voltage  
25 is output, and

26 the bypass transistor brings the first output line and  
27 the second output line into conduction to bypass the clamp  
28 capacitance in a state where a read voltage that is not in  
29 the predetermined range is output to the first output line  
30 and so no voltage is held by the clamp capacitance, so that  
31 brightness information indicating high brightness is output.

1 6. The imaging device of Claim 3,  
2 wherein the output unit further includes a voltage  
3 supplying unit operable to supply a bias voltage to a gate  
4 of the bypass transistor.

1 7. The imaging device of Claim 3,  
2 wherein the bypass transistor is a depletion-mode  
3 transistor.

1           8. The imaging device of Claim 3,  
2           wherein each unit cell includes:  
3           a light-receiving element operable to generate charge  
4           according to an amount of incident light;  
5           a charge detecting unit operable to hold the charge  
6           generated by the light-receiving element and output the charge  
7           as a voltage signal;  
8           a reset transistor that is connected in series between  
9           a reset terminal for supplying a reference voltage and the  
10          charge detecting unit, and when a gate voltage is applied  
11          thereto, the reset transistor is brought into conduction,  
12          so that the charge detecting unit is reset to the reference  
13          voltage; and  
14          an amplifier transistor that is connected between an  
15          amplifier terminal for supplying a reference voltage and the  
16          first output line, and when a voltage signal converted by  
17          the charge detecting unit is applied to a gate thereof, the  
18          voltage signal is amplified and the amplified voltage signal  
19          is output to the first output line, and  
20          wherein a barrier potential of the bypass transistor  
21          is higher by a predetermined amount than an electric potential  
22          of a saturation signal that is an output of the amplifier  
23          transistor and that depends on an electric potential of the  
24          reset transistor being out of conduction.

1           9. The imaging device of Claim 8,  
2           wherein a difference between the barrier potential of  
3           the bypass transistor and the electric potential of the  
4           saturation signal is substantially 0.1V.

1           10. The imaging device of Claim 8,  
2           wherein the output unit further includes a voltage  
3           supplying unit operable to supply a bias voltage to a gate  
4           of the bypass transistor, and  
5           wherein a difference between the barrier potential of  
6           the bypass transistor and the electric potential of the  
7           saturation signal is set by the bias voltage.

1           11. The imaging device of Claim 10,  
2           wherein the bypass transistor and the reset transistor  
3           are manufactured in one process.

1           12. The imaging device of Claim 10,  
2           wherein the voltage supplying unit includes a bias  
3           setting circuit that enables an appropriate bias unique to  
4           the imaging device to be set from outside.

1           13. The imaging device of Claim 8,  
2           wherein the reset transistor is manufactured by a  
3           predetermined process of burying through injection, and

4 the bypass transistor is manufactured by the  
5 predetermined process of burying through injection and an  
6 additional injection process, and

7 wherein a difference between the barrier potential of  
8 the bypass transistor and the electric potential of the  
9 saturation signal is set by the additional injection process.

1 14. The imaging device of Claim 8,

2 wherein a first substrate bias voltage is applied to  
3 the bypass transistor, the first substrate bias voltage having  
4 an electric potential different from a second substrate bias  
5 voltage applied to the reset transistor, and

6 wherein a difference between the barrier potential of  
7 the bypass transistor and the electric potential of the  
8 saturation signal is controlled by a difference between the  
9 first substrate bias voltage and the second substrate bias  
10 voltage.

1 15. The imaging device of Claim 3,

2 wherein the output unit further includes a clip  
3 transistor operable to output, as brightness information  
4 indicating high brightness, a voltage matching an input  
5 dynamic range of the circuit of the subsequent stage that  
6 is an analogue circuit, when a voltage that is a difference  
7 between an electric potential of the first output line and



8 an electric potential of the second output line is not in  
9 the predetermined range.

1 16. The imaging device of Claim 15,  
2 wherein the clip transistor is connected between a  
3 terminal for supplying a voltage corresponding to a maximum  
4 voltage of the input dynamic range of the circuit of the  
5 subsequent stage and the second output line, and when a  
6 predetermined voltage is applied to a gate thereof, the clip  
7 transistor is temporarily brought into conduction, so that  
8 a voltage matching the input dynamic range is output from  
9 the second output line to the circuit of the subsequent stage,  
10 and  
11 the output unit further includes a clip transistor  
12 control unit operable to pulse drive the clip transistor by  
13 temporarily bringing the clip transistor into conduction,  
14 where a pulse voltage is applied to a gate of the clip transistor  
15 when the circuit of the subsequent stage inputs the brightness  
16 information.

1 17. The imaging device of Claim 3,  
2 wherein the output unit further includes;  
3 a sampling transistor that is connected in series between  
4 the first output line and the clamp capacitance; and  
5 a sampling transistor control unit operable to bring

6 the sampling transistor out of conduction in a vertical  
7 blanking period during which brightness information is not  
8 output from the imaging unit.

1 18. The imaging device of Claim 3,

2 wherein each unit cell includes:

3 an amplifier transistor that is connected in series  
4 between an amplifier terminal for supplying a reference  
5 voltage and the first output line, and when a voltage signal  
6 converted by a charge detecting unit is applied to a gate  
7 thereof, the voltage signal is amplified and the amplified  
8 voltage signal is output to the first output line; and

9 a select transistor that is connected in series between  
10 the amplifier terminal and the amplifier transistor or between  
11 the amplifier transistor and the first output line, and

12 the output unit further includes:

13 a load transistor operable to read the output voltage  
14 via the amplifier transistor and the select transistor by  
15 loading the first output line when the load transistor is  
16 in conduction; and

17 a control unit operable to

18 (a) bring a select transistor included in one or more  
19 of the unit cells into conduction before bringing the load  
20 transistor into conduction,

21 (b) bring the load transistor out of conduction before

22 bringing select transistors included in all the unit cells  
23 out of conduction, and

24 (c) bring the load transistor out of conduction during  
25 a vertical blanking period during which brightness  
26 information is not output from any of the unit cells.

1 19. An imaging method for use in an imaging device that  
2 includes an imaging area formed by a plurality of unit cells  
3 arranged one dimensionally or two-dimensionally, and outputs  
4 brightness information according to an amount of incident  
5 light, each unit cell including a photoelectric conversion  
6 part that generates a first output voltage in a reset state  
7 and a second output voltage according to an amount of incident  
8 light, and each unit cell generating a reset voltage  
9 corresponding to the first output voltage and a read voltage  
10 corresponding to the second output voltage, the method  
11 comprising:

12 a judgment step of judging, in relation to each unit  
13 cell, whether the read voltage is in a predetermined range;

14 a first output step of outputting brightness information  
15 indicating a difference between the reset voltage and the  
16 read voltage when the read voltage is judged to be in the  
17 predetermined range; and

18 a second output step of outputting brightness  
19 information indicating high brightness when the read voltage

20 is judged not to be in the predetermined range.